Ground beetles (Coleoptera: Carabidae) associated with Garry Oak Ecosystems on Southern Vancouver Island, British Columbia

J.A. McLEAN[1,4], A.L. BEHENNAH[1,2] and M. FAIRBARNS[3]

ABSTRACT

The ground beetle populations under 60% Garry Oak forest cover at Mary Hill and Rocky Point on the Southwest fringe of Vancouver Island were assessed in September/ October 2003 using pitfall traps. Two groups of five pitfall traps were set out at each location and collected weekly. The dominant species recovered was *Pterostichus algidus* which made up more than 75% of the insects caught at Mary Hill and more than 90% of the insects caught at Rocky Point. Thirteen species of carabid beetles were recorded.

INTRODUCTION

Garry oak (*Quercus garryana* Dougl.) ecosystems of Southern Vancouver Island constitute a biodiversity hotspot in British Columbia. This study is a contribution to define the inventory of ground beetles (Coleoptera: Carabidae) in areas that contained at least 60% Garry oak. The study area occurs within the Coastal Douglas-fir Zone (CDFmm) near its western (wetter) limits. This biogeoclimatic zone is restricted to low elevations (<150m) along southeast Vancouver Island, the southern Gulf Islands and a small portion of the nearby mainland. The zone is characterized by warm, dry summers and mild, wet winters and has the mildest climate in Canada. Forests of Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), often with a secondary component of grand fir (*Abies grandis* Dougl. Ex D. Don) or western redcedar (*Thuja plicata* Donn ex D. Don), tend to dominate well-drained sites with medium textured soils. Drier sites, such as our study area, are dominated by Garry oak and/or arbutus (*Arbutus menziesii* Pursh) (Green and Klinka, 1994).

The Rocky Point area is close to a large concentration of First Nations' (aboriginal) burial cairns and was almost certainly on the edge of a major First Nations village. Both the Rocky Point and Mary Hill sites have been logged. Most of the Garry oak stands, especially along the western part of the CDF, were fire maintained for centuries and are now reverting to Douglas-fir – hence the spreading canopies of many of the Garry oak trees indicating that they grew in an open meadow (Fairbarns, 2008).

Ground beetles (Coleoptera: Carabidae) have been widely used in recent years as one of the indicators of forest change in Canada, especially in measuring the impacts of various harvesting regimes. In general, pitfall trapping of arthropods is more a measure of activity than density (Work *et al.* 2008). The taxonomic support for the Carabidae in Canada and North America is provided by an extensive set of keys developed by Lindroth (1963-9). The biological notes for these species have been summarized by Larochelle and Larivière (2003). The objective of this study was to determine the ground beetle species richness in a relatively undisturbed Garry oak dominated ecosystem.

[1] Department of Forest Sciences, Faculty of Forestry, University of British Columbia, 3034-2424 Main Mall, Vancouver, B.C. V6T 1Z4
[2] 1829 Laval Avenue, Victoria, B.C. V8N 1M9
[3] Aruncus Consulting, 2130 Kings Road, Victoria, B.C. V8R 2P9
[4] Corresponding author john.mclean@ubc.ca

MATERIALS AND METHODS

Study Locations. Two locations within the Department of National Defence lands on Southwestern Vancouver Island, that had greater than 60% Garry oak cover, were selected as secure trapping areas for this study. One was in the vicinity of Mary Hill (48°20'32"N, 123°32'50"W) and the other was near Rocky Point (48°19'20"N, 123°32'30"W). In each area, two trapping sites were set up (MH1 and MH2 at Mary Hill and RP1 and RP2 at Rocky Point) approximately 100 m apart. At each site, 5 pitfall traps were set out in a semicircle. Inter-trap distances were ~25m. The hole for the pitfall trap was excavated with a bulb planter that resulted in minimal disturbance of the litter layer that reduced digging-in effects (Greenslade, 1973). Two plastic 500mL plastic cups (8cm lip diameter and 10cm deep) were inserted into the holes with the upper (inner) cup lip at the litter level. The outer cup retained the soil allowing easy removal of the inner cup for sample collection. The 75mL of polypropylene glycol was changed at each collection. Each trap was covered with a 30 cm square of marine plywood supported on 3cm risers at each corner to act as a rain and debris cover. Traps were set out on September 7th, 2003 and collected each week until October 5th, 2003.

Three of the sites (MH1, MH2 and RP1) were in vernally moist meadows overrun by robust exotic grasses. Each was surrounded by Garry oak in various mixtures with arbutus, grand fir and Scotch Broom (*Cytisus scoparius* (L.)). RP2 differed in that mature grand fir, Douglas-fir, arbutus and Garry oak dominated the site and the pitfall traps were set in the litter layer under these tree canopies where there was the lightest presence of grasses. The Rocky Point sites were within 100m of the rocky shoreline while the Mary Hill Sites were more than 500m inland.

Vegetation Survey. A qualitative survey was made of the dominant species in each site as well as some detail of the vegetation around each pitfall trap. These data were especially useful for evaluating species which showed restricted distributions.

Data Analyses. Sørenson's C_s similarity index (Southwood and Henderson 2000) was used to compare species richness between sites within locations and between locations, where $C_s = 2J/(2J+A+B)$, and A = number of species unique to Site A; B = number of species unique to Site B and J = the number of species common to both. This index ranges from 0.0, no common species, to 1.0, all species being common to the two samples, and has been rated as one of the better similarity measures by Smith (1986). Rank order abundance plots (Southwood and Henderson 2000) were made to demonstrate level of species abundance and richness at each site. ANOVA was used to compare *Pterostichus algidus* numbers among collecting locations and weeks. Tukey's Test was used for pairwise comparisons (Statistix 7, 2000).

RESULTS AND DISCUSSION

A total of 1188 ground beetles, in 13 species, were collected with the dominant species (*Pterostichus algidus)* making up more than 85% of the total catch (Table 1). Significantly greater numbers of *P. algidus* were caught on the Rocky Point sites than on the Mary Hill sites. Lower numbers of *P. algidus* were caught in the second week when the mean daily temperature was lower and the highest weekly rainfall was recorded (Fig. 1, Table 2). *P. algidus* is known as a species that is common in mixed forests and has been noted above sea beaches, as we found in RP1 and RP2 (Larochelle and Larivière 2003).

The second most abundant species captured was *Trechus obtusus* (Table 1) that was found in both locations but notably absent from RP2, where traps were set out in the litter layer and the grasses were sparse. In the other three sites, with the vernally moist meadows, traps that caught the

Table 1.
Numbers of ground beetles captured at each study site ordered by total numbers of individuals captured.

Species	Location (Pitfall Trap Weeks)				Total
	Mary Hill 1 (20)	Mary Hill 2 (19)	Rocky Point 1 (20)	Rocky Point 2 (20)	
Pterostichus algidus LeConte	187a[1]	128a	343b	361b	1019
Trechus obtusus Erichson[2]	9	6	49	0	64
Calathus fuscipes (Goeze)[2]	27	12	0	0	39
Carabus nemoralis O.F. Müller[2]	8	12	0	0	20
Zacotus matthewsii LeConte	0	8	5	1	14
Harpalus cautus Dejean	4	0	5	0	9
Scaphinotus angusticollis (Fisher von Waldheim)	2	2	0	3	7
Pterostichus herculaneus Mannerheim	0	0	0	5	5
Scaphinotis marginatus (Fisher von Waldheim)	0	1	4	0	5
Harpalus somnulentus Dejean	0	3	0	0	3
Harpalus affinis (Scrank)	0	1	0	0	1
Omus dejani Reiche	0	1	0	0	1
Poecilus lucublandus Say	1	0	0	0	1
Totals	**238**	**174**	**406**	**370**	**1188**

[1] Significantly more *Pterostichus algidus* captured at Rocky Point than at Mary Hill ANOVA, Tukey's Test, ($p<0.001$).
[2] Species noted as of recent European origin (Spence and Spence 1988)

Table 2.
Average weekly catch per trap of *Pterostichus algidus* and associated weekly weather data (as recorded at William Head, Environment Canada).

For week ending	Average number *P. algidus*/trap/week	Average daily temperature °C	Total weekly rainfall (mm)
September 14th	13.6a[1]	13.6	5.6
September 21st	7.4b	12.9	6.8
September 28th	17.1a	15.2	0
October 5th	12.9a	13.8	0

[1] Significantly fewer *P. algidus* captured in the second week, ANOVA, Tukey's Test, $p<0.001$.

highest numbers of *T. obtusus* were in grassy areas near the edge of overstory canopies. Scotch broom was also noted near these traps. The next two most abundant species, *Calathus fuscipes* and *Carabus nemoralis,* were confined to the Mary Hill sites. These two species (as well as *T. obtusus*) were recorded by Spence and Spence (1988) as being of recent European origin. The sex ratios (males per female) for the four most numerous species (see Table 1) were 0.90, 0.45, 0.29, 0.50 respectively

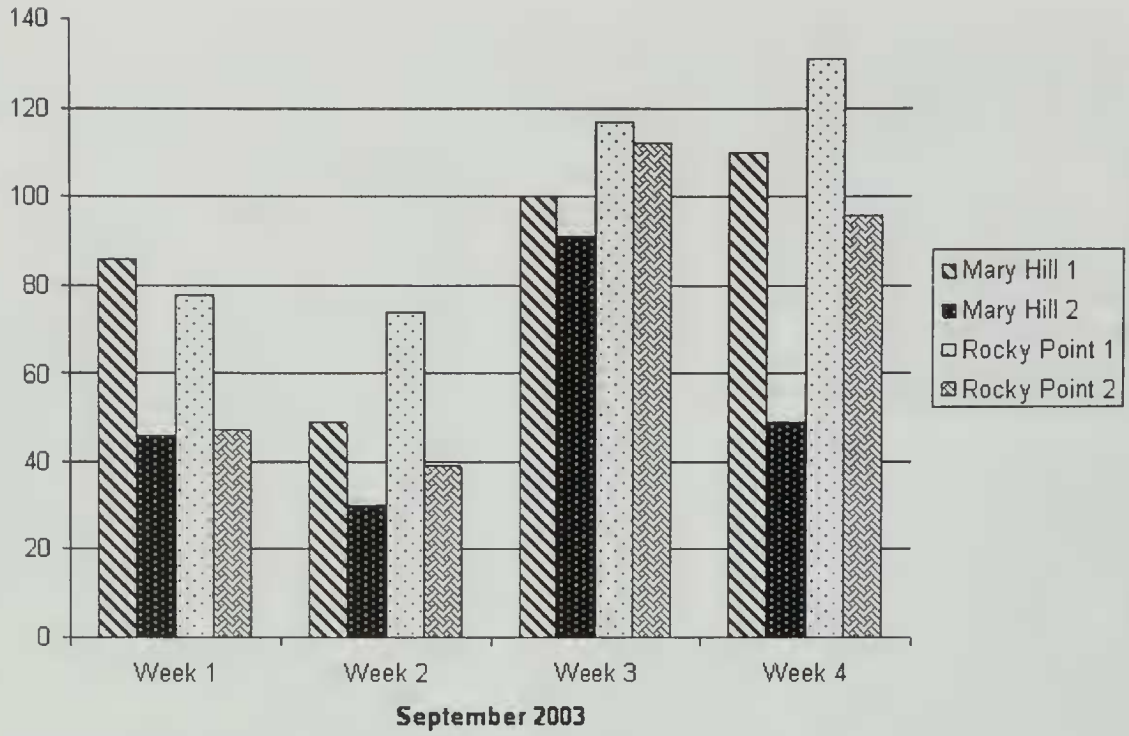

Figure 1. Total numbers of beetles captured in pitfall traps set out on DND Lands, Vancouver Island in September/October 2003 (5 traps per location).

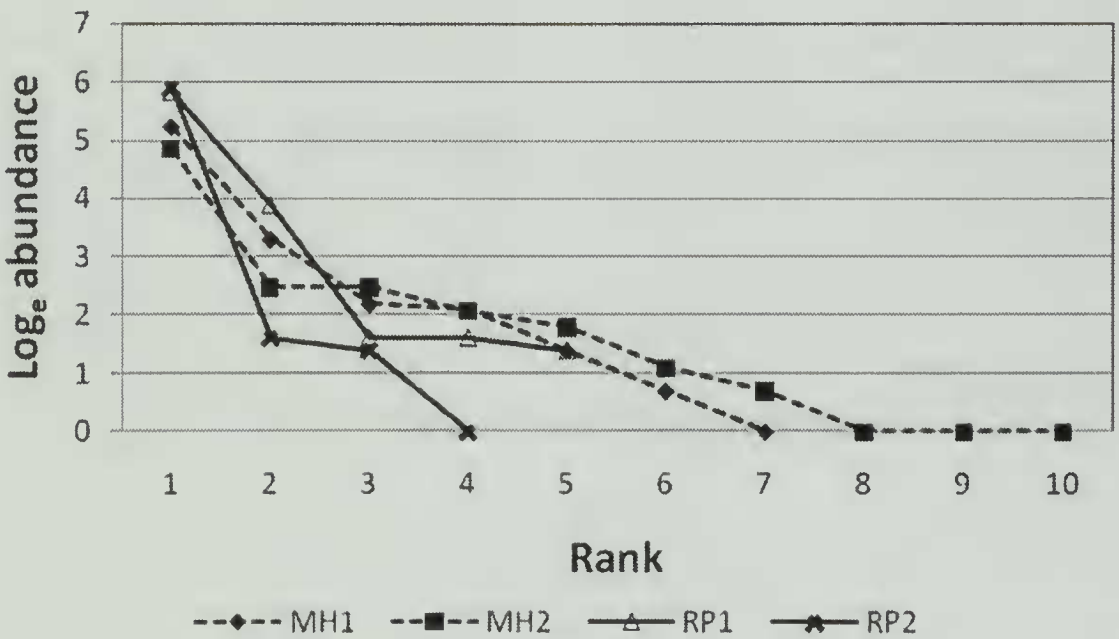

Figure 2. Rank order abundance plots for the carabid communities at Mary Hill and Rocky Point, Southern Vancouver Island, September/October 2003.

showing that more females than males were captured.

The similarity coefficients (Table 3) were calculated to compare catches for sites within locations (MH1,MH2; RP1,RP2) and between locations (MH,RP). Six of the 7 species captured at the Rocky Point sites were also caught at Mary Hill which resulted in a higher similarity index for the two locations than between sites in the same location. The rank order abundance plots (Fig. 2) show that a single species (see *P. algidus* in Table 1) dominated all catches.

A major concern in developing efficient biodiversity conservation is knowing the biodiversity already present and something of its distribution (Leather *et al.* 2008). This brief study documents the species that are active in the fall in a Garry oak community. The three exotic species from Europe are well established in the area.

Table 3.
Similarity indices for the ground beetle catches at Mary Hill and Rocky Point. Based on data in Table 1.

	Parameters[1]			
Comparison	**A**	**B**	**J**	**Sørensen Coefficient (Cs)**
Mary Hill 1 vs Mary Hill 2	2	5	5	0.588
Rocky Point 1 vs Rocky Point 2	3	2	2	0.444
Mary Hill vs Rocky Point	6	1	6	0.632

[1] Parameters for the Sørenson Coefficient (Cs): A = Unique species in first group, B = unique species in second group, J = species in both groups being compared.

ACKNOWLEDGEMENTS

We thank S. Carson and I.T. Behennah for assistance in the field. J. Jarrett reviewed the ground beetle identifications. Support was provided by the Environmental Science Committee of Natural Resources Canada and study sites were made available through the kind offices of CFB Esquimalt. Funding was provided by the Kathleen and Sheldon Rothwell Forest Research Fund at UBC Forestry.

REFERENCES

Fairbarns, M. 2008. Biodiversity hotspots in British Columbia – Garry Oak Ecosystems. http://www.geog.ubc.ca/biodiversity/GarryOakEcosystems.html

Green, R.N. and K. Klinka. 1994. A field guide to site identification and interpretation for the Vancouver Forest Region. British Columbia Ministry of Forests Land Management Handbook #28. 285 pp.

Greenslade, P. 1973. Sampling ants with pitfall traps: digging-in effects. Insectes Sociaux 20: 343-353

Larochelle, A. and Larivière, M-C. 2003. A natural history of the ground beetles (Coleoptera:Carabidae) of America north of Mexico. Penasoft Publishers, Sophia, Bulgaria. XX pp.

Leather, S.R., Y. Basset and B.A. Hawkins. 2008. Insect conservation: finding the way forward. Insect Conservation and Diversity 1: 67-69.

Lindroth, C.H. 1963-9. The ground-beetles of Canada and North America. Opulsca Entomologica Supplenta. 20, 24, 26, 29, 33, 34, 35:1-1192.

Smith, B. 1986. Evaluation of Different Similarity Indices Applied to Data from the Rothamsted Insect Survey. University of York, York. (cited in Southwood and Henderson, 2000).

Southwood, T.R.E. and P.A. Henderson. 2000. Ecological Methods (3rd Edition). Blackwell Science. 575 pp.

Spence, J.R and D.H. Spence. 1988. Of ground beetles and men: Introduced species and the synanthropic fauna of western Canada. Mem. ent. Soc. Can. 144: 151-168.

Statistix 7, 2000. User's Manual, Analytical Software, Florida, USA.359 pp.

Work, T.T., M. Koivula, J. Klimaszewski, D. Langor, J. Spence, J. Sweeney and C. Hebert, 2008. Evaluation of carabid beetles as indicators of forest change in Canada. Canadian Entomologist 140: 393-414.